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Industrial Development and Environment Protection

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Abstract: *The purpose of economic development in any region is to provide opportunities for improved living and jobs to people. While industrial development invariably creates more jobs in any region, possibilities of adverse effects on the environment also increase, if adverse effects are not reduced. Industrialisation has led to environmental degradation in terms of industrial pollution. With industries operating, a 100 per cent pollution-free environment is a myth. It is neither possible nor necessary. However, it is imperative to ensure that industrial units cause the least pollution. Adequate and effective pollution control measures are required so that adverse effects on the environment are minimised. Necessary technological know-how and institutional back up support are available in this regard. Dust, smoke, fumes and toxic gas emissions occur as a result of highly-polluting industries such as thermal power plants, coal mines, cement, sponge iron, steel & ferroalloys, petroleum and chemicals. In industry-specific clusters, these have not only become hazardous, but also cause irreparable damage to our ecology and environment, often breaching the environment's carrying capacity. High emission level of pollutants at industrial clusters has been reported in Raipur-Durg, Korba-Bilaspur, Vapi-Ankleswar, Dhanbad-Bokaro, Vizag, Tarapur and Ludhiana. This is despite the fact that the number of power plants switched over to super-critical technology. Steel, cement, chemicals and petroleum refineries have adopted state-of-the-art technologies. There is an urgent need to review and rework the strategies of setting up industry-specific clusters based on comparative advantage.*

Keywords: *industrial, development, environmental, protection, sustainable, pollution, degradation.*

INTRODUCTION

While industrialization provides economic and social development, industrial buildings and factories are a large contributor to environmental pollution. It's important that we find a balance of meeting human economic and social needs, including job creation and government revenue, and ensuring environmental protection. Sustainable industrial development works to minimize its environmental footprint while maintaining economic growth, social advancement and quality of life.¹

3 key elements of sustainable industrial development

Resource efficiency

Sustainable industrial development ensures that resources are used conservatively and efficiently. To achieve resource productivity, manufacturers must optimize the supply circle, analyzing how raw materials are extracted, how components are produced, how products are designed and how return

markets are organized.² Consider new business models in which you have more control over all of your operations to make sure you're exercising environmental safety.

Pollution Control

One of the most important components of sustainability is minimizing environmental impact through pollution prevention. Pollution results from waste, which can be reduced, reused or prevented to ensure environmental protection. There are many ways to manage industrial air pollution in manufacturing, which include using clean energy sources and air pollution destruction technologies.³

Safe Chemical Management

By practicing safe chemical management, industrial businesses can minimize health effects caused by environmental emissions significantly. Safe chemical management avoids relying on raw materials that have the potential to become toxic once released into the water or air. Eliminate hazardous materials containing chromium, mercury and lead from your supply chain and replace them with non-hazardous alternatives.⁴

The Sustainable & Environment-Friendly Industrial Production project is being implemented jointly by GIZ and the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The aim of the project is to mitigate a number of nationally significant environmental problems, with the main focus placed on industrial waste water management. The project demonstrates methods for the reduction of acute environmental pollution and for improving resource efficiency in industrial production. This involves piloting technical solutions as well as business and management models at selected sites, achieving positive results and direct impacts in terms of improved environmental conditions. These pilot approaches will serve as examples for subsequent replication nationwide.⁵

The project activities are grouped into the following areas:

- environment-oriented modernisation of three industrial areas (showcasing solutions)
- establishing conducive conditions at the national and state levels
- knowledge management and dissemination

These activities focus on the conveyance, treatment, recycling and reuse of waste water, the management of sewage sludge, monitoring systems, and improving processes in individual industries. The measures are complemented by training and skills development, as well as the creation of a virtual platform for the exchange of best practice technologies. The project also supports efforts to establish an enabling framework at central and state levels. To this end, it proposes new measures for the policies, plans and support programmes intended to prevent or reduce pollution and to improve resource efficiency in industrial zones. Actors, such as industry associations, industrial site operators and private companies, as well as relevant entities at the central and state levels, are all encouraged to get involved in the project at various stages. Women are steadily emerging as change-makers in terms of behavioural change to overcome environmental problems.⁶ For this reason, the project is working to create practical management and planning approaches for sustainable industrial zones that are oriented toward the inclusion of women. The pilot locations for the project are selected industrial areas in the states of Uttarakhand, Gujarat and Delhi. In these states, it is expected that the project will lead to the adoption of technological and managerial best practices promoting efficient, environment- and climate-friendly industrial development in 10 industrial zones.⁷

Discussion

With the coming of the Industrial Revolution, humans were able to advance further into the 21st century. Technology developed rapidly, science became more advanced, and the manufacturing age came into view. With all of these comes one more effect: industrial pollution. Earlier, industries were small factories that produced smoke as the primary pollutant. However, since the number of factories was limited and worked only a certain number of hours a day, the levels of pollution did not grow significantly. But when these factories became full-scale industries and manufacturing units, the issue of industrial pollution started to take on more importance. Industrial pollution is the pollution caused by the industry.⁸ Together with the industrial revolution, more factories and technologies were developed, which caused a lot of air, land, and water pollution on our planet. This kind of pollution is one of the worst because the smoke that the industry emits in the air contributes a lot to ozone depletion, health problems to both animals and humans, and global warming. Furthermore, the waste from these industries is being thrown on land and water, which causes a lot of health problems as well for both animals and plants. These industrial pollutants release a lot of harmful and unnatural chemicals into both soil and water, which eventually lead to the extinction of some plant and animal species. We abuse land because we regard it as a commodity belonging to us.⁹ When we see land as a community to which we belong, we may begin to use it with love and respect. ~ Aldo Leopold

Any form of pollution that can trace its immediate source to industrial practices is known as industrial pollution. Most of the pollution on the planet can be traced back to industries of some kind. In fact, the issue of industrial pollution has taken on grave importance for agencies trying to fight against environmental degradation. Countries facing sudden and rapid growth of such industries are finding it to be a serious problem that has to be brought under control immediately. Industrial pollution takes on many faces. It contaminates several sources of drinking water, releases unwanted toxins into the air and reduces the quality of soil all over the world. Major environmental disasters have been caused due to industrial mishaps, which have yet to be brought under control. Below are a few of the causes of industrial pollution that have resulted in environmental degradation.¹⁰

Causes of Industrial Pollution

1. Lack of Policies to Control Pollution

Lack of effective policies and poor enforcement drive allowed many industries to bypass laws made by the pollution control board, which resulted in mass-scale pollution that affected the lives of many people.¹¹

2. Unplanned Industrial Growth

In most industrial townships, unplanned growth took place wherein those companies flouted rules and norms and polluted the environment with both air and water pollution.

3. Use of Outdated Technologies

Most industries still rely on old technologies to produce products that generate a large amount of waste. To avoid high costs and expenditure, many companies still make use of traditional technologies to produce high-end products.¹²

4. Presence of a Large Number of Small Scale Industries

Many small-scale industries and factories that don't have enough capital and rely on government grants to run their day-to-day businesses often escape environmental regulations and release a large number of toxic gases into the atmosphere.

5. Inefficient Waste Disposal

Water pollution and soil pollution are often caused directly by inefficiency in the disposal of waste. Long-term exposure to polluted air and water causes chronic health problems, making the issue of industrial pollution a severe one. It also lowers the air quality in surrounding areas, which causes many respiratory disorders.¹³

6. Leaching of Resources from Our Natural World

Raw materials are required in large quantities by industries in order to produce finished goods. This requires the extraction of minerals from beneath the earth. The extracted minerals can cause soil pollution when spilled on the earth. Leaks from vessels can cause oil spills that may prove harmful to marine life.

7. Natural Resource Use

Raw materials are a must for industries, which often requires them to pull out underground elements. One of the most common forms of leaching from natural resources is fracking for oil. When industries extract minerals, the process causes soil pollution and also causes oil leaks and spills that are harmful and even deadly to people and animals.¹⁴

Effects of Industrial Pollution on Our Environment

1. Water Pollution

The effects of industrial pollution are far-reaching and liable to affect the ecosystem for many years to come. Most industries require large amounts of water for their work. When involved in a series of processes, the water comes into contact with heavy metals, harmful chemicals, radioactive waste, and even organic sludge. These are either dumped into open oceans or rivers. As a result, many of our water sources have a high amount of industrial waste in them, which seriously impacts the health of our ecosystem. The same water is then used by farmers for irrigation purposes, which affects the quality of food that is produced. Water pollution has already rendered many groundwater resources useless for humans and wildlife. It can, at best, be recycled for further usage in industries¹⁵

2. Soil Pollution

Soil pollution is creating problems in agriculture and destroying local vegetation. It also causes chronic health issues for the people that come into contact with such soil on a daily basis.

3. Air Pollution

Air pollution has led to a steep increase in various illnesses, and it continues to affect us on a daily basis. With so many small, mid-sized and large-scale industries coming up, air pollution has taken a toll on the health of the people and the environment.¹⁶

4. Wildlife Extinction

By and large, the issue of industrial pollution shows us that it causes natural rhythms and patterns to fail, meaning that the wildlife is being affected in a severe manner. Habitats are being lost, species are becoming extinct, and it is getting harder for the environment to recover from each natural disaster. Major industrial accidents like oil spills, fires, the leakage of radioactive materials and damage to property are harder to clean up as they have a higher impact in a shorter timeframe.

5. Global Warming

With the rise in industrial pollution, global warming has been increasing at a steady pace. Smoke and greenhouse gases are being released into the air by industries, which is causing an increase in global

warming. Melting of glaciers; extinction of polar bears; floods; tsunamis; and hurricanes are a few of the effects of global warming.¹⁷

6. Biodiversity Loss

Industrial pollution continues to cause significant damage to the earth and all of its inhabitants due to chemical wastes, pesticides, radioactive materials, etc. It affects wildlife and ecosystems and disrupts natural habitats. Animals are becoming extinct, and habitats are being destroyed. The growing amount of liquid, solid and hazardous wastes endangers ecosystem health and jeopardizes food, water, and health security. Industrial pollution disasters, including oil spills and radioactive leakage, take years to decades to clean up.

7. Atmospheric Deposition

Cadmium enrichment of soil can also be associated with industrial pollution. Topsoils contaminated by mine spoil showed a wide range of Cd concentrations. Industrial effluents are commonly discharged to surface water drainage systems after clarification in tailing ponds. Recent investigations have disclosed very high concentrations of Cd in the overbank and bottom sediments of the rivers.

Ways to Control or Reduce Industrial Pollution

The issue of industrial pollution is critical to every nation on the planet. With the increase in the harmful effects of industrial pollution, there are many agencies and individuals who are working to reduce carbon footprints and live and work in an eco-friendly way. However, industrial pollution is still rampant and will take many years to properly control and regulate. Many steps can be taken to seek permanent solutions to the problem.¹⁸

1. Source Control

Adopting new technology, efficient training of employees for safe use, and development of better technology for disposal of waste, and being more conscientious about the use of raw materials can help control industrial pollution at the source.

2. Recycling

Recycling as much polluted water in the industries as possible by increased recycling efforts to reduce industrial pollution.

3. Cleaning of Resources

Organic methods should be adopted to clean the water and soil, such as using microbes that use heavy metals and waste as feed naturally. Cooling rooms or bins need to be developed that allow industries to recycle the water they need instead of pushing it back into the natural water source it came from.¹⁹

4. Industry Site Selection

Consideration of the location of the sites and the potential impact on the surrounding environment can help reduce harmful consequences.

5. Proper Treatment of Industrial Waste

By developing and implementing adequate treatment facilities for handling industrial waste and proper habits can reduce pollution.

6. Rebuilding Habitats and Afforestation

Rebuilding habitats by planting more trees and plants can help give wildlife back their homes, and the trees can help purify the air with enough oxygen and act as a buffer against the environment.²⁰

7. Stricter Laws and Enforcement

The Environmental Protection Agency (EPA) works to correct the damage from industrial pollution. There should be more stringent rules to take action against companies who do not follow proper protocol and more significant rewards for companies that operate properly. It requires creating policies that prevent the misuse of land.

8. Regular Environmental Impact Assessments

Being a responsible company or industry should require regular environmental impact assessments that are reported for evaluation. If there are harmful impacts discovered during the review, necessary actions to correct the negative consequences should be developed and enforced.²¹

How do industries pollute the environment

Industries pollute the environment by releasing their toxic waste into bodies of water, land, and air. Industries manufacture most of their products in factories. The factories release toxic smoke into the air, which pollutes our environment. The smoke contains chemicals that are unnatural and toxic for the environment, as well as gases that are harmful to the atmosphere. With that, animals, plants, and humans may inhale the smoke from the factories, which could lead to health complications or worse death. Other than that, other gases are causing the depletion of the ozone layer, which contributes to global warming. On the other hand, industries also use water for their manufacturing. The excess water used by factories is being dumped or released again into open oceans or rivers. The toxic chemicals that go along with the dumped factory excess water could reach aquatic animals and harm them. Other than that, the water is also being processed again for commercial use, which could affect plants, animals, and humans as they consume it, or the water is being used for irrigation. With that, the water cycle of the environment is being severely disrupted and harmed, making some sources useless for consumption. Furthermore, industries pollute the environment by throwing their liquid and solid waste on land. The waste causes soil pollution, which leads to agricultural problems as well as chronic health issues for humans and animals. Lastly, industries pollute the environment, which leads to the extinction of some animal and plant species. Due to the accumulative effects of industrial pollution, the environment is continuously being affected by its disruption, affecting its natural system. A lot of soil is becoming inhabitable for plants; global warming is becoming so severe that even glaciers are melting and polar bears are losing their home; more natural disasters are happening and are not being controlled by nature anymore; and animals are continuously losing their homes.²²

Results

Industrial development and environmental protection cannot be achieved without establishing the concept of industrial ecology. The main tools necessary for establishing industrial ecology are cleaner production, environmental management systems, and zero pollution. The concept of industrial ecology will help the industrial system to be managed and operated more or less like a natural ecosystem hence causing as less damage as possible to the surrounding environment. The 7-Rs golden rule encompasses regulation, reducing, reusing, recycling, recovering, rethinking, and renovation, and is the basic tool for industrial ecology.

Establishing industrial ecology within the industrial activities will avoid landfill, incineration and/or treatment. The cost of treatment and safe disposal of waste through incineration or landfills is escalating exponentially. Locating waste disposal sites (landfills) are becoming more difficult and expensive. The environmental and health impacts of landfills and incinerations are becoming more dangerous and disaster for the community and national economy. Industrial ecology can be considered as science of sustainability promises much in improving the efficiency of human use of the ecosystem. Technological

improvements are not always better in the full sense of sustainability without taking environment into consideration, where zero pollution is a must for industrial ecology. Cooperation and community are also important parts of the ecological metaphor of sustainability. Industrial developments of recent decades are generally agreed to have improved the quality of human life.²³ However, improper handling of industrial, mining, and waste disposal has contributed to soil and water contamination worldwide. The most common pollutants near industrial and potentially toxic sites are As, Cu, Cd, Cr, Pb, and Zn. The intervention of man in the natural landscape has led to degraded areas, reduction of natural areas, and an increase in environmental pollution. Industrial activities have intensified the environmental pollution, promoting the improper disposal of domestic and industrial waste, especially harmful waste, resulting in contamination of soil, air, surface, and underground water resources. The procedure for remediation and consequent recovery of these areas is slow and is related to soil restoration capacity. The chemical, physical, and biological characteristics are recomposed to a minimum level that allows the development of plant species and microbial activity, establishing a succession of macrobiotics. In soil, water, and air a wide variety of chemicals are found such as pesticides, metals, and other hazardous toxins and pollutants. All heavy metals and their compounds have toxicity, i.e., the ability to cause toxic effects to the biological system. Among pollutants, heavy metals present a concern to human health due to their toxicity, mutagenicity, and carcinogenicity.

Thus, it is necessary to search for environmentally sustainable alternatives. Phytoremediation can be an alternative solution, with lower costs and less intensive labor. Phytoremediation is a method that uses plants and microorganisms to reduce the soil, water, or sediment contamination caused by heavy metals, pesticides, and toxic organic compounds²⁴. This technology has been used for years in many countries and has shown to lower cost and demonstrates greater efficiency in removing contaminants over other physical and chemical techniques. Plants can bioconcentrate (phytoextraction) as well as bioimmobilize or inactivate (phytostabilization) toxic heavy metals through in situ rhizospheric processes. Phytoremediation process is utilized to treat various wastes and remediate areas where the process works to remove metals or metalloids from the environment. The success of phytoremediation is dependent on the potential of the plants to yield high biomass and withstand metal stress. Additionally, the metal bioavailability in rhizosphere soil is considered another critical factor that determines the efficiency of metal translocation and the phytostabilization process²⁵.

Plants have been utilized for contamination remediation since the 1970s, and the term phytoremediation began to be widely recognized by the government and commercial sectors during the 1980s. Phytoremediation is an in situ, cost-effective potential strategy for cleanup of sites contaminated with metals. This challenge needs planning and precision to create conditions to establish natural ecological processes at each contaminated area, inserting plant species without causing biota imbalance. Plant rhizosphere interactions with soil contaminants are the key factor in phytoremediation technologies. The phytoremediation techniques applied depends on plant properties, and most common are phytoextraction, phytostabilization,²⁶ phytovolatilization, and phytostimulation. Phytoextraction, use plants to absorb contaminants or metals through their roots. According to researchers the plant roots absorb the contaminants from the soil and translocates to the aerial part of the plant, where they are accumulated and collected by biomass. Phytostabilization uses the plants as vegetation cover, reducing the mobility and availability of contaminants, and contributes to the entry of the food chain. This technique uses plant canopy to reduce wind dispersion, while plant roots prevent water erosion, immobilize heavy metals, and reduces leaching. Phytovolatilization is a technique that uses plants and water to absorb pollutants (including organic contaminants) that are released to the atmosphere as vapor through stomata, reducing the toxicity of the substance by plant transpiration process. Phytostimulation occurs by microbial biodegradation that is stimulated through root exudates and/or supply of plant tissues, contributing to the contaminant elimination. Additionally, some authors report that the phytodegradation process promotes

organic xenobiotics absorption and degradation by plants through a process of enzyme action and rhizodegradation (using the microbiology from rhizosphere microorganisms). This process occurs because plant roots change soil conditions by increasing aeration, changing moisture levels, and producing exudates that favor the growth of microorganisms. Depending on the plant species, a polluted area can generate useful products or ecosystem services. This can include soil stabilization, biomass or biofuel production, and carbon sequestration. Usually, these plants remove the pollutant without destroying the soil superficies, while maintaining or improving the soil utility and fertility.²⁷

Conclusions

The issue of economic growth and the environment essentially concerns the kinds of pressures that economic growth, at the national and international level, places on the environment over time. The relationship between ecology and the economy has become increasingly significant as humans gradually understand the impact that economic decisions have on the sustainability and quality of the planet. Economic growth is commonly defined as increases in total output from new resources or better use of existing resources; it is measured by increased real incomes per capita. All economic growth involves transforming the natural world, and it can effect environmental quality in one of three ways. Environmental quality can increase with growth. Increased incomes, for example, provide the resources for public services such as sanitation and rural electricity. With these services widely available, individuals need to worry less about day-to-day survival and can devote more resources to conservation. Second, environmental quality can initially worsen but then improve as the growth rate rises. In the cases of air pollution, water pollution, and deforestation and encroachment there is little incentive for any individual to invest in maintaining the quality of the environment. These problems can only improve when countries deliberately introduce long-range policies to ensure that additional resources are devoted to dealing with them. Third, environmental quality can decrease when the rate of growth increases. In the cases of emissions generated by the disposal of municipal solid waste, for example, abatement is relatively expensive and the costs associated with the emissions and wastes are not perceived as high because they are often borne by someone else. The World Bank estimated that, under present productivity trends and given projected population increases, the output of developing countries would be about five times higher by the future than it is today.²⁸ The output of industrial countries would rise more slowly, but it would still triple over the same period. If environmental pollution were to rise at the same pace, severe environmental hardships would occur. Tens of millions of people would become sick or die from environmental causes, and the planet would be significantly and irreparably harmed. Yet economic growth and sound environmental management are not incompatible. Economic growth will be undermined without adequate environmental safeguards, and environmental protection will fail without economic growth. The earth's natural resources place limits on economic growth. These limits vary with the extent of resource substitution, technical progress, and structural changes. For example, in the late 1960s many feared that the world's supply of useful metals would run out. Yet, today, there is a glut of useful metals and prices have fallen dramatically. The demand for other natural resources such as water, however, often exceeds supply. In arid regions such as the Middle East and in non-arid regions such as northern China, aquifers have been depleted and rivers so extensively drained that not only irrigation and agriculture are threatened but the local ecosystems. Some resources such as water, forests, and clean air are under attack, while others such as metals, minerals, and energy are not threatened. This is because the scarcity of metals and similar resources is reflected in market prices. Here, the forces of resource substitution, technical progress, and structural change have a strong influence. But resources such as water are characterized by open access, and there are therefore no incentives to conserve.²⁹ Effective policies designed to sustain the environment are most necessary because society must be made to take account of the value of natural resources and governments must create incentives to protect the

environment. Economic and political institutions have failed to provide these necessary incentives for four separate yet interrelated reasons:

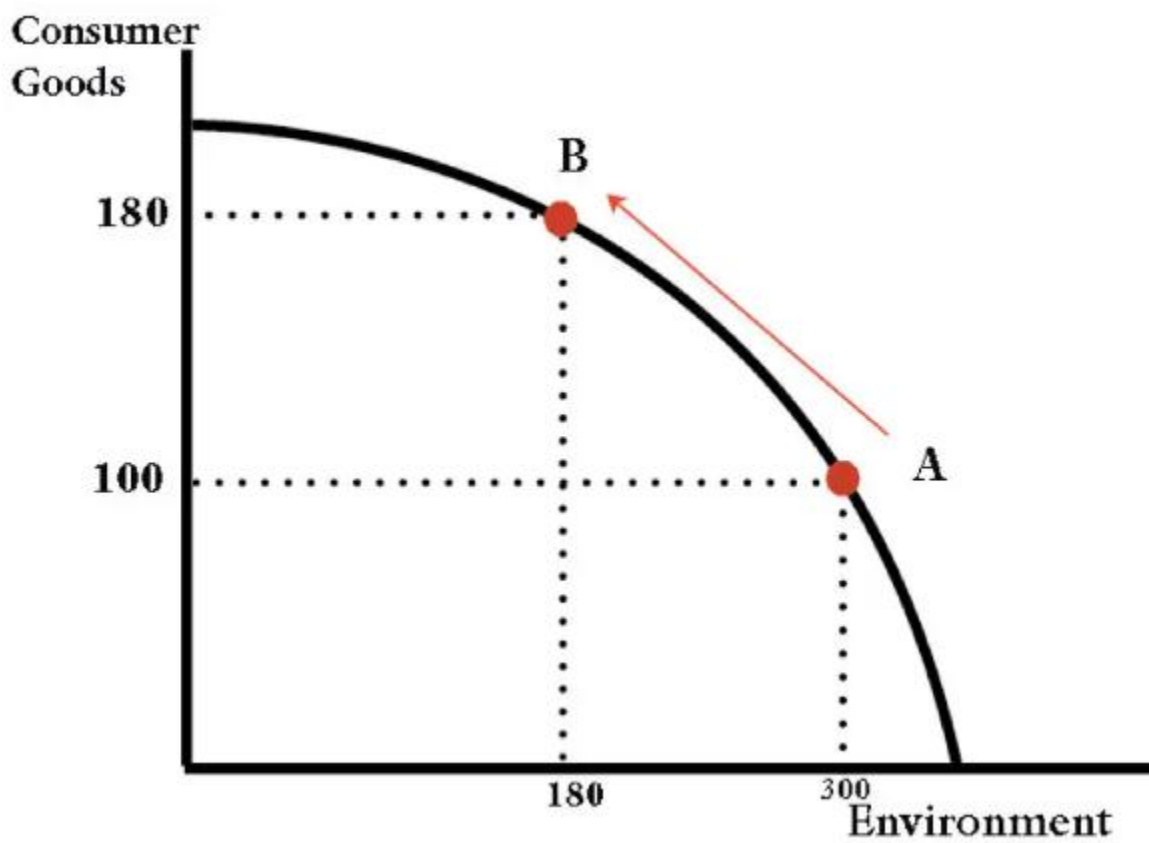
1. short time horizons;
2. failures in property rights;
3. concentration of economic and political power; and
4. immeasurability and institutional uncertainty.

Although economists and environmentalists disagree on the definition of sustainability, the essence of the idea is that current decisions should not impair the prospects for maintaining or improving future living standards. The economic systems of the world should be managed so that societies live off the dividends of the natural resources, always maintaining and improving the asset base. Promoting growth, alleviating poverty, and protecting the environment may be mutually supportive objectives in the long run, but they are not always compatible in the short run. Poverty is a major cause of environmental degradation, and economic growth is thus necessary to improve the environment.³⁰ Yet, ill-managed economic growth can also destroy the environment and further jeopardize the lives of the poor. In many poor but still forested countries, timber is a good short-run source of foreign exchange. When demand for Indonesia's traditional commodity export—petroleum—fell and its foreign exchange income slowed, Indonesia began depleting its hardwood forests at non-sustainable rates in order to earn export income. In developed countries, it is competition that can shorten time horizons. Competitive forces in agricultural markets, for example, induce farmers to take short-term perspectives for financial survival. Farmers must maintain cash flow to satisfy bankers and make a sufficient return on their land investment. They therefore adopt high-yield crops, monoculture farming, increased fertilizer and pesticide use, salinizing irrigation methods, and more intensive tillage practices which cause erosion. "The Tragedy of the Commons" is the classic example of property rights failure. When access to a grazing area, or commons is unlimited, each herdsman knows that grass not eaten today will not be there tomorrow. As a rational economic being, each herdsman seeks to maximize his gain and adds more animals to his herd. No herdsman has an incentive to prevent his livestock from grazing the area.³¹ Degradation follows and the loss of a common resource. In a society without clearly defined property rights, those who pursue their own interests ruin the public good. The cheapest methods of avoiding loss of mineral revenues has been to hurry the development of oil and gas in areas which might revert to open water, thereby, hastening erosion and saltwater intrusion, or putting up levies around the property to maintain it as private property, thus interfering with normal estuarine processes. Global or transnational problems such as ozone layer depletion or acid rain produce a similar problem. Countries have little incentive to reduce damage to the global environment unilaterally when doing so will not reduce the damaging behavior of others or when reduced fossil fuel use would leave that country at a competitive disadvantage. International agreements are thus needed to impose order on the world's nations that would be analogous to property rights. Concentration of wealth within the industrialized countries allows for the exploitation and destruction of ecosystems in less developed countries (LDC) through, for example, timber harvests and mineral extraction. The concentration of wealth inside a less developed country skews public policy toward benefiting the wealthy and politically powerful, often at the expense of the ecosystem on which the poor depend.³² Local sustainability is dependent upon the goals of those who have power—goals which may or may not be in line with a healthy, sustainable ecosystem. Furthermore, when an exploiting party has substitute ecosystems available, it can exploit one and then move to the next. Japanese lumber firms harvest one country and then move on to another. Here the benefits of sustainability are low and exploiters have shorter time horizons than local interests. This is also an example of how the high discount rates in developed countries are imposed on the management of developing countries' assets²³. Policy-makers and

institutions are often unable to grasp the direct and indirect effects of policies on ecological sustainability, nor do they know how their actions will affect other areas not under their control. Many contemporary economists and environmentalists argue that the value of the environment should nonetheless be factored into the economic policy decision-making process. The goal is not necessarily to put monetary values on environmental resources ; it is rather to determine how much environmental quality is being given up in the name of economic growth, and how much growth is being given up in the name of the environment. A danger always exists that too much income growth may be given up in the future because of a failure to clarify and minimize tradeoffs and to take advantage of policies that are good for both economic growth and the environment. Economic development is often put ahead of environmental sustainability as it involves people's standards of living. However, quality of life can decline if people live in an economic place with a poor environmental quality because of economic development.²⁴

Economic growth means an increase in real output (real GDP). Therefore, with increased output and consumption we are likely to see costs imposed on the environment. The environmental impact of economic growth includes the increased consumption of non-renewable resources, higher levels of pollution, global warming and the potential loss of environmental habitats. However, not all forms of economic growth cause damage to the environment. With rising real incomes, individuals have a greater ability to devote resources to protecting the environment and mitigate the harmful effects of pollution. Also, economic growth caused by improved technology can enable higher output with less pollution.²⁵

Classic trade-off between economic growth and environmental resources



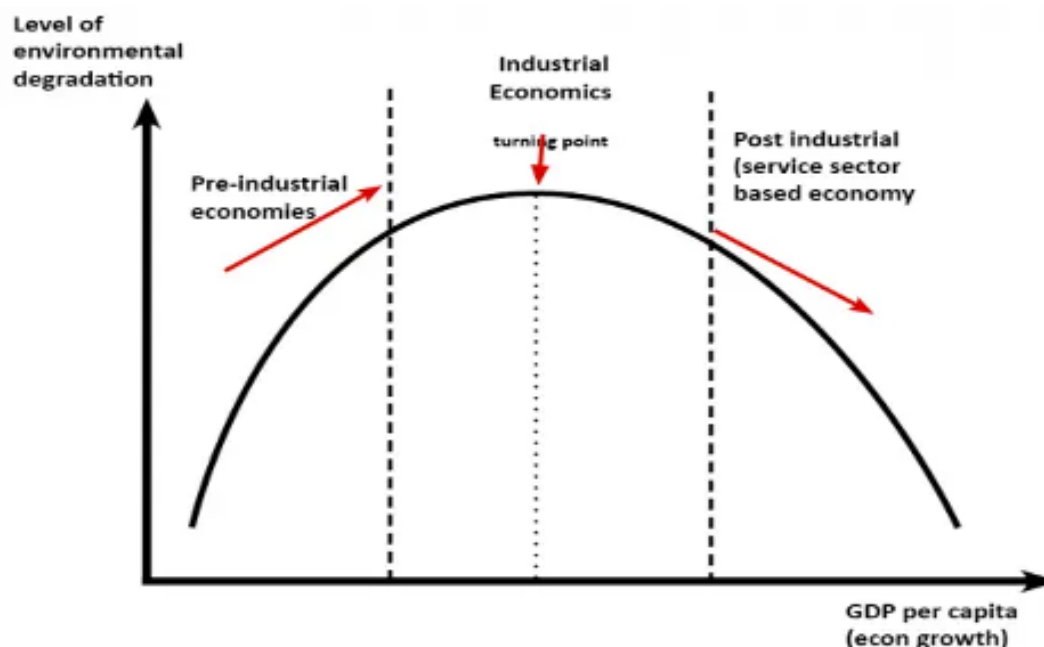
This PPF curve shows a trade-off between non-renewable resources and consumption. As we increase consumption, the opportunity cost implies a lower stock of non-renewable resources. For example, the pace of global economic growth in the past century has led to a decline in the availability of natural resources such as forests (cut down for agriculture/demand for wood)

1. A decline in sources of oil/coal/gas
2. Loss of fishing stocks – due to overfishing²⁶
3. Loss of species diversity – damage to natural resources has led to species extinction.

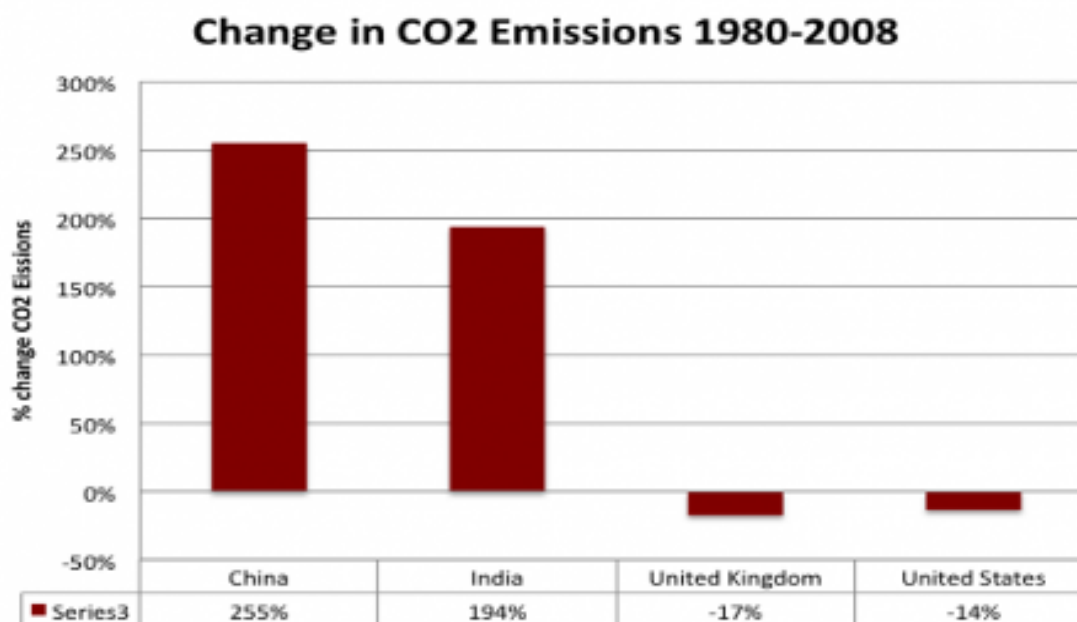
Increased consumption of fossil fuels can lead to immediate problems such as poor air quality and soot, (London smogs of the 1950s). Some of the worst problems of burning fossil fuels have been mitigated by Clean Air Acts – which limit the burning of coal in city centres. Showing that economic growth can be consistent with reducing a certain type of pollution. While smogs were a very clear and obvious danger, the effects of increased CO₂ emissions are less immediately obvious and therefore there is less incentive for policymakers to tackle. Scientists state the accumulation of CO₂ emissions have contributed to global warming and more volatile weather. All this suggests economic growth is increasing long-term environmental costs – not just for the present moment, but future generations.²⁷

Air/land/water pollution causes health problems and can damage the productivity of land and seas. Global warming leads to rising sea levels, volatile weather patterns and could cause significant economic costs. Deforestation resulting from economic development damages soil and makes areas more prone to drought. Economic growth leads to resource depletion and loss of biodiversity. This could harm future ‘carrying capacity of ecological systems’ for the economy. Though there is uncertainty about the extent of this cost as the benefit of lost genetic maps may never be known. Economic growth creates long-term waste and toxins, which may have unknown consequences. For example, economic growth has led to increased use of plastic, which when disposed of do not degrade. So there is an ever-increasing stock of plastic in the seas and environment – which is both unsightly but also damaging to wildlife.²⁸

U-Shaped curve for economic growth and the environment



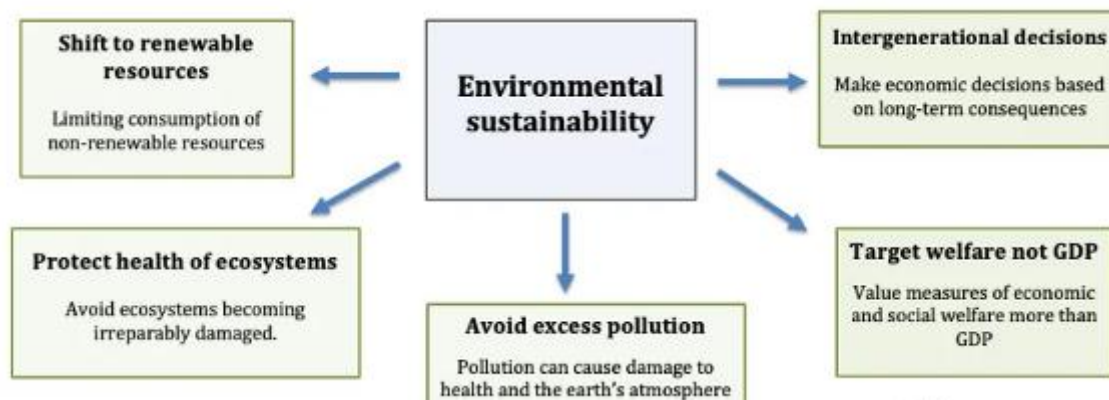
One theory of economic growth and the environment is that up to a certain point economic growth worsens the environment, but after that the move to a post-industrial economy – it leads to a better environment.²⁹



For example – since 1980, the UK and the US have reduced CO2 emission. The global growth in emissions is coming from developing economies. Another example – In early days of growth, economies tend to burn coal/wood – which cause obvious pollution. But, with higher incomes, an economy can promote cleaner technology which limits this air pollution. However, in a paper “Economic growth and carrying capacity” by Kenneth Arrow et al. they caution about this simplistic u-shape. As the authors state: “Where the environmental costs of economic activity are borne by the poor, by future generation, or by other countries, the incentives to correct the problem are likely to be weak”. It may be true there is a Kuznets curve for some types of visible pollutants, but it is less true of more diffuse and less visible pollutants. (like CO₂). The U-shaped maybe true of pollutants, but not the stock of natural resources; economic growth does not reverse the trend to consume and reduce the quantity of non-renewable resources. Reducing pollution in one country may lead to the outsourcing of pollution to another, e. g. we import coal from developing economies, effectively exporting our rubbish for recycling and disposal elsewhere. Environmental policies tend to deal with pressing issues at hand but ignore future intergenerational problems.³⁰

The economic growth will damage the environment, and damage will itself start to act as a brake on growth and will force economies to deal with economic damage. In other words, the environment will force us to look after it. For example, if we run down natural resources, their price will rise and this will create an incentive to find alternatives. This is more pessimistic suggesting that economic growth leads to an ever-increasing range of toxic output and problems, some issues may get solved, but they are outweighed by newer and more pressing problems which are difficult if impossible to overturn. This model has no faith that the free-market will solve the problem because there is no ownership of air quality and many of the effects are piling up on future generations; these future effects cannot be dealt with by the current price mechanism. This suggests that in the early stages of economic growth, there is little concern about the environment and often countries undermined environmental standards to gain a competitive advantage – the incentive to free-ride on others’ efforts. However, as the environment increasingly worsens, it will reluctantly force economies to reduce the worst effects of environmental damage. This will slow down environmental degradation but not reverse past trends.³¹

Economic growth without environmental damage



Some ecologists argue economic growth invariably leads to environmental damage. However, there are economists who rightly argue that economic growth can be consistent with a stable environment and even improvement in the environmental impact. This will involve. A recent report suggests that renewable energy is becoming cheaper than more damaging forms of energy production such as burning coal and in 2018 – this has led to a 39% drop in new construction starts from 2017, and an 84% drop since 2015. If economic growth causes external costs, economists state it is socially efficient to include the external cost in the price (e. g. carbon tax). If the tax equals the full external cost, it will lead to a socially efficient outcome and create a strong incentive to promote growth that minimises external costs. Environmental policy which protects the environment, through regulations, government ownership and limits on external costs can, in theory, enable economic growth to be based on protection of the environmental resource. It is possible to replace cars running on petrol with cars running on electricity from renewable sources. This enables an increase in output, but also a reduction in the environmental impact. There are numerous possible technological developments which can enable greater efficiency, lower costs and less environmental damage. Include quality of life and environmental indicators in economic statistics. Rather than targetting GDP, environmental economists argue we should target a wider range of living standards + living standards + environmental indicators. (e. g. Genuine Progress Indicators GPI)³²

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